Furthermore, certain cutting applications require what are referred to as "dual flow" nozzles to be used, these nozzles comprising, in addition to an axial gas passage, at least one lateral gas passage passing through the nozzle body and arranged in proximity to said axial passage. The presence of this or these additional passages makes it difficult to machine a housing in the body of the nozzle, i.e. to widen the initial axial passage in order to allow an internal movable element to be placed therein.

Moreover, the solution consisting in arranging a movable element in the axial passage of a conventional nozzle, without widening said passage beforehand, is unsatisfactory since it decreases the space available for the passage of the focused laser beam. This results in a risk of heating or even deterioration of the internal walls of the movable element and/or the nozzle body, which would also decrease cutting performance and/or quality and the productivity of the process.

The problem addressed is thus that of how to mitigate all or some of the aforementioned drawbacks by providing a laser nozzle that especially may allow the effectiveness of the gas used in laser cutting to be improved, while being much easier to implement industrially and of much improved lifespan relative to existing solutions, and that may furthermore be compatible with most, even all, existing conventional laser nozzles.

A first aspect of the present invention provides a laser nozzle comprising:

a nozzle body comprising a first axial passage and an inlet orifice allowing said first axial passage to be supplied with assistance gas;

an external cover comprising an axial housing and a first outlet orifice located in a front face of said external cover , the nozzle body being arranged at least partially in said axial housing;

a movable element comprising a second axial passage and a front portion forming a skirt, said movable element being arranged between the external cover and the nozzle body and being translationally movable in the axial housing of the external cover; and

an elastic element arranged in the axial housing, between the external cover and the nozzle body,

wherein the movable element is able and designed to move translationally in the axial housing in the direction of the first outlet orifice under the effect of a gaseous pressure of said assistance gas, said pressure being applied in said axial housing and exerted on said movable element, said elastic element exerting an elastic return force on the movable element tending to oppose the translational movement of the movable element in the axial housing in the direction of the first outlet orifice.

Depending on the case, the nozzle according to embodiments of the invention may comprise one or more of the following technical features:

- the axial housing of the external cover comprises a first outlet orifice located in a front face of said external cover, the movable element being able and designed to move translationally in the axial housing, in the direction of the first outlet orifice, until the front portion forming a skirt of the movable element protrudes out of the axial housing through said first outlet orifice of the axial housing.

- the nozzle body, the external cover and the movable element are axisymmetric parts arranged coaxially relative to one another, the nozzle body comprising a front portion arranged at least partially in the second axial passage of the movable element.

- the first axial passage of the nozzle body comprises a second outlet orifice located in the front portion of said nozzle body and the second axial passage of the movable element comprises a third outlet orifice located in the front portion forming a skirt of the movable element, said third outlet orifice opening downstream of said second outlet orifice when the front portion protrudes out of the axial housing.

- the movable element is able and designed to move translationally in the axial housing in the direction of the first outlet orifice under the effect of a gaseous pressure applied in said axial housing and exerted on said movable element.

- the nozzle body comprises at least one gas supply duct arranged within said nozzle body and bringing the first axial passage of the nozzle body and the axial housing of the external cover into fluidic communication.

- an elastic element is arranged in the axial housing, between the external cover and the nozzle body, said elastic element exerting an elastic return force on the movable element tending to oppose the translational movement of the movable element in the axial housing in the direction of the first outlet orifice.

- the axial housing comprises an internal shoulder, preferably arranged in the bottom of said axial housing, and the external peripheral wall of the movable element comprises an abutment arranged facing said shoulder, the elastic element being arranged between the abutment and the internal shoulder.

- the nozzle furthermore comprises a tubular element forming a sleeve about all or some of the front portion of the nozzle body, the tubular element being formed from an electrically insulating material.

- the movable element is able to move between a plurality of positions comprising:

. a rest position in which the front portion of the movable element is completely or almost completely retracted into the axial housing; and

. a working position in which the skirt of the front portion of the movable element completely or almost completely protrudes out of the axial housing, through the third outlet orifice.

A second aspect of the invention provides a laser focusing head comprising at least one focusing optical element, characterized in that it furthermore comprises a laser nozzle according to the first aspect.

Moreover, a third aspect of the invention also provides a laser apparatus comprising a laser generator, a laser focusing head and a laser beam guiding device connected to said laser generator and to

said laser focusing head, characterized in that the laser focusing head is as defined in the second aspect.

Preferably, the generator or laser source is a CO_2, YAG, fiber or disk laser, preferably a fiber or disk laser and especially a ytterbium fiber laser source.

According to another aspect, the invention also relates to a laser beam cutting process, which employs a nozzle according to the first aspect, a laser focusing head according to the second aspect or an apparatus according to the third aspect.

The invention will now be better understood by virtue of the following description given with reference to the appended figures, in which:

- figure 1A schematically shows a focusing head of a conventional laser cutting apparatus;
- figure 1B schematically shows the size of the laser spot relative to the size of the nozzle orifice;
- figure 2 shows a schematic cross-sectional view of a nozzle according to one embodiment of the invention;
- figures 3A and 3B show schematic cross-sectional views of certain constituent elements of a nozzle according to one embodiment of the invention;
- figure 4 shows a schematic cross-sectional view of a nozzle according to another embodiment of the invention, the movable element occupying a different position to that shown in figure 2; and
- figures 5A and 5B schematically show a nozzle according to the invention in operation, the movable element occupying two different positions.

Figure 1A shows the focusing head 20 of a conventional laser cutting apparatus, to which a conventional laser nozzle 21 is fastened, said nozzle being passed through by a focused laser beam and by the assistance gas (arrow 23) that serves to expel metal melted by the beam out of the cutting kerf 31 formed by the beam 22 in the metal part 30 to be cut, for example a sheet of steel or stainless steel.

The assistance gas may be an active gas, such as oxygen, air, CO_2 or hydrogen, or an inert gas such as argon, nitrogen or helium, or a mixture of a number of these active and/or inert gases. The composition of the gas is especially chosen depending on the nature of the part to be cut.

The beam, which is made to impact the part, will melt, at this point of impact, the metal, which will be expelled under the part by the pressure of the assistance gas.

Figure 1B shows the flow cross-sectional area S1 of the orifice 24 of the nozzle 21 relative to the size S2 of the focal spot of the beam 22. As may be seen, the area S1 is very

Claims

1. A laser nozzle comprising:

- a nozzle body comprising a first axial passage and an inlet orifice allowing said first axial passage to be supplied with assistance gas;

- an external cover comprising an axial housing and a first outlet orifice located in a front face of said external cover, the nozzle body being arranged at least partially in said axial housing;

- a movable element comprising a second axial passage and a front portion forming a skirt, said movable element being arranged between the external cover and the nozzle body and being translationally movable in the axial housing of the external cover; and

- an elastic element arranged in the axial housing, between the external cover and the nozzle body,

wherein the movable element is able and designed to move translationally in the axial housing in the direction of the first outlet orifice under the effect of a gaseous pressure of said assistance gas, said pressure being applied in said axial housing and exerted on said movable element, said elastic element exerting an elastic return force on the movable element tending to oppose the translational movement of the movable element in the axial housing in the direction of the first outlet orifice.

2. The nozzle as claimed in claim 1, wherein the movable element is able and designed to move translationally in the axial housing, in the direction of the first outlet orifice, until the front portion forming a skirt of the movable element protrudes out of the axial housing through said first outlet orifice (14) of the axial housing.

3. The nozzle as claimed in one of the preceding claims, wherein the nozzle body, the external cover and the movable element are axisymmetric parts arranged coaxially relative to one another, the nozzle body comprising a front portion arranged at least partially in the second axial passage of the movable element.

4. The nozzle as claimed in one of the preceding claims, wherein the first axial passage of the nozzle body comprises a second outlet orifice located in

the front portion of said nozzle body and the second axial passage of the movable element comprises a third outlet orifice located in the front portion forming a skirt of the movable element, said third outlet orifice opening downstream of said second outlet orifice when the front portion protrudes out of the axial housing.

5. The nozzle as claimed in one of the preceding claims, wherein the nozzle body comprises at least one gas supply duct arranged within said nozzle body and bringing the first axial passage of the nozzle body and the axial housing of the external cover into fluidic communication.

6. The nozzle as claimed in one of the preceding claims, wherein the axial housing comprises an internal shoulder, preferably arranged in the bottom of said axial housing, and the external peripheral wall of the movable element comprises an abutment arranged facing said internal shoulder, the elastic element being arranged between the abutment and the internal shoulder.

7. The nozzle as claimed in one of the preceding claims, wherein it furthermore comprises a tubular element forming a sleeve about all or some of the front portion of the nozzle body, the tubular element being formed from an electrically insulating material.

8. The nozzle as claimed in one of the preceding claims, wherein the movable element is able to move between a plurality of positions comprising:

- a rest position in which the front portion of the movable element is completely or almost completely retracted into the axial housing; and
- a working position in which the skirt of the front portion of the movable element completely or almost completely protrudes out of the axial housing, through the third outlet orifice.

9. A laser focusing head comprising at least one focusing optical element, wherein it furthermore comprises a laser nozzle as claimed in one of the preceding claims.

10. A laser apparatus comprising a laser generator, preferably a CO_2, YAG, fiber or disk laser, a laser focusing head and a laser beam guiding device connected to said laser generator and to said laser focusing head, wherein the laser focusing head is as claimed in claim 9.

11. The apparatus as claimed in claim 10, wherein it comprises a gas source and at least one gas supply line fluidically connecting the focusing head and said gas source, the first passage of the laser nozzle body being fluidically connected to the focusing head, and the movable element moving translationally in the axial housing of the nozzle body when the gas source supplies the focusing head and the laser nozzle.

12. A laser beam cutting process, which employs a nozzle as claimed in one of claims 1 to 8, a laser focusing head as claimed in claim 9 or an apparatus as claimed in one of claims 10 and 11.